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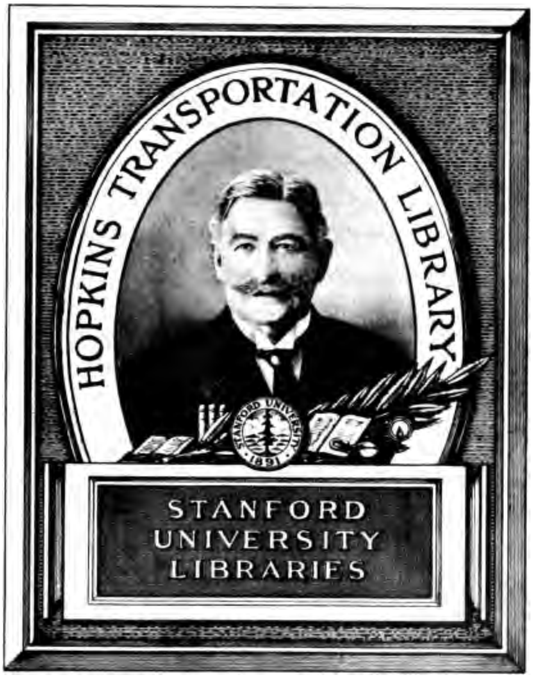
Account of some recent improvements in the system of navigating the Ganges.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ACCOUNT

OF

SOME RECENT IMPROVEMENTS

IN THE SYSTEM OF

NAVIGATING THE GANGES

BY IRON STEAM VESSELS.

BY ALBERT ROBINSON,
CIVIL ENGINEER.

London:
JOHN WEALE, 59, HIGH HOLBORN.
1848.

2851

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KING'S HEAD COURT, GOUGH SQUARE.

TO THE RIGHT HONORABLE

WILLIAM BINGHAM BARING, M.P.,

LATE SECRETARY OF THE BOARD OF CONTROL FOR THE AFFAIRS
OF INDIA,

This little Work

ON THE

STEAM NAVIGATION OF THE GANGES,

IS DEDICATED AS A TRIBUTE OF HIGH ESTEEM FOR HIS
PUBLIC CHARACTER, AND AS A TOKEN OF GRATITUDE
FOR PERSONAL KINDNESS, BY

HIS OBEDIENT HUMBLE SERVANT,

THE AUTHOR.

wars in which they have been forced to engage, the peculiar political relations in which they stand to several States, and the immense extent of the regions under their sway.

The recent and still unfinished Revolutions in Europe, so inimical to the security of investments of any kind, must tend to direct a greater degree of attention to India,—that land of industrious millions, of accumulated wealth, and of immense natural resources, which the justice and moderation, more than even the bravery, of Britons has bound to us by the strongest and most enduring ties;—and it is difficult to conceive that any more legitimate, any more fructifying, or any less doubtful subject for the investment of capital can exist, than the judicious improvement of the internal communications of a country already possessing population and wealth, and thus allied to us, whether by the formation of good common Roads, Canals, and Railways, or by improving the Navigation of the rivers, by introducing Steam Navigation and by extending and improving it where it already exists.

The projected introduction of Railways in India has added a new feature to the subject. The perfection and beauty of railway steam locomotion, as a means of transit, make it deservedly popular in all countries; and, when considered in connection with India (by those especially who have a personal acquaintance with the country), it becomes almost dazzling to the mind. The aspirations of the author are with those who look forward to the introduction of Railways in India as a consummation devoutly to be wished, if limited in the first instance, as it no doubt will be, to those great lines where the political and military demand for them combine with commercial and social wants of India, to such an extent as to render it imperative upon the Indian Government to take the initiative in the construction, out of the revenues of India, at least of the railway itself.

It is in no spirit of rivalry that he thus gives publicity to facts that may be presumed to be in antagonism to the formation of the intended East India Railway between Delhi and Calcutta; but those who are well acquainted with the resources and traffic of the populous and rich region watered by the Ganges, will acquit him of any hostility to the projected line; since they will be fully aware that not only can a large Steam Navigation Traffic on the Ganges co-exist with the line when it shall be made, but that each will prosper all the more from the existence and success of the other.

It will not be expected that any elaborate inquiry should be here entered into as to the mode in which or the extent to which such results may be predicated: the author would merely desire to guard those unacquainted with this part of India from falling into the error, that any very considerable portion of the present enormous *goods* traffic on the Ganges can ever be absorbed by the intended railway;—many circumstances of a local nature, and in connection with the habits of the natives of India, forbid the notion; but even independently of the operation of these circumstances, it will be perceived, by reference to the map, that the *goods* traffic to and from all the most populous and wealthy Districts which lie upon both banks of the Ganges and Hooghly, between Benares and Calcutta, named Azimgur, Goruckpore, Ghazepore, Sarun, Tirhoot Purnea, Dinajepore, Malda, Pubna, on the north bank, and Shahabad, Patna, Behar, Bhaugulpore, Moorshedabad, and Nudya, on the south bank, with a population of upwards of 15 millions, and an area of 23,000 miles,—and which include the cities and towns of Benares, Dinapore, Patna, Ghazepore, Buxar, Chuprah, Bhullea, Mongheer, Bhaugulpore, Carragola-Ghaut, Rajmahal, Rampore Baulea, Jellinghee, Goraee, Comercallee, Koolna, Moorshedabad, Berhampore, Cutwa, Nudya,—must ever continue to be carried upon the Ganges.

This great natural water-way possesses then an inherent value which cannot be taken away from it; and it is much to be desired that public attention were more strongly directed to the fact, and to its immense importance as a means of internal communication in India, and to the improvements of which it is susceptible.

The following pages contain a sketch of the navigation of the Ganges, of the vessels by which it is navigated, and an account of a system of Steam Navigation new to India, and lately brought into successful operation by the author. The circumstances that led to his becoming the instrument of effecting its introduction were, his having visited the United States some years ago, and becoming acquainted with the Steam Navigation of the great rivers of America, and his having afterwards, while in the practice of his profession in London, entered into a correspondence with some Indian capitalists upon the subject of steamers for the Ganges. In 1843, he arrived in India, and having carefully surveyed the Ganges from Allahabad downwards, and communicated his plans to his friends, they formed an association for the purpose of procuring from England, and placing on the Ganges, a line of steamers upon his designs and specifications. During the interval of their construction by his firm in London, he remained in India, and had the satisfaction of starting the first two steamers himself, and testing them fully.

Further experience has confirmed the soundness of the principles upon which the new system is based; and the writer may now, he trusts, without presumption, point to the steamers in question as a stride, at least, in the right direction.

The author ventures to hope that the possession of literary ability will not be considered essential to the performance of the humble task he has undertaken. He has aimed at stating his facts in the plainest language, avoiding technicalities as much as possible; and should the arrangement be found to be faulty, or the style deficient in clearness, he would deprecate any harsh criticism upon the production of a few brief hours, snatched at intervals from the active duties of his profession.

A. R.

Blackheath-park,
London, 15th April, 1848.

THE GANGES.

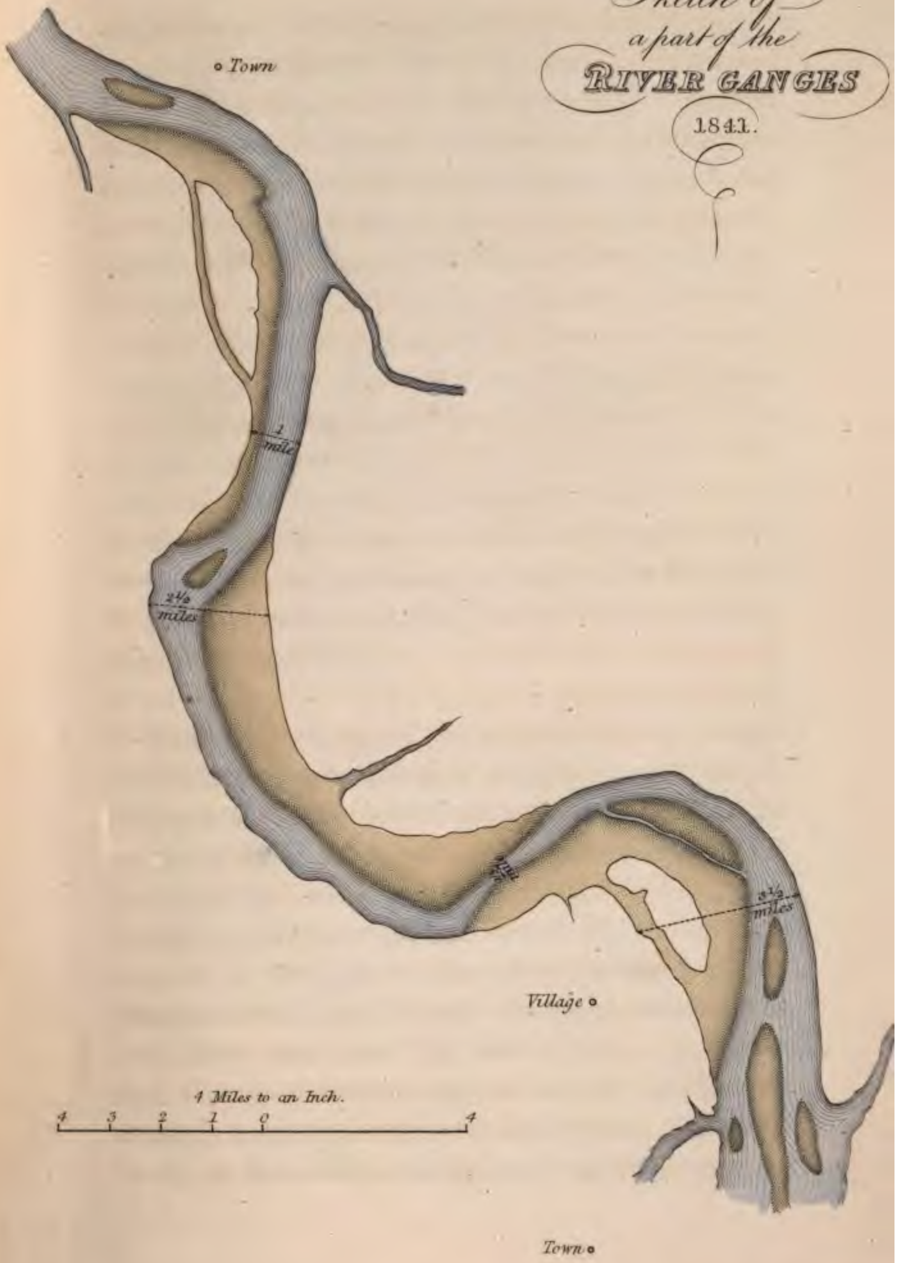
Its Features—Seasons—Course of the Navigation—Traffic.

The European reader, accustomed to the rivers of a temperate climate, cannot easily form a correct idea of the Ganges: it may therefore be acceptable in the first place to describe briefly its general features with reference to Steam Navigation between Allahabad, where it commences, and Calcutta, the great sea-port of Bengal, where it terminates.

The country through which it flows may be said to be one immense plain, the soil of which contains a very large portion of sand, and is of course easily acted on by running waters. The bed which the river has formed for itself in such a soil is, as might be expected, tortuous or devious in its course, and of very irregular breadth and depth: being composed of loose sand, it is kept in constant motion, and the changes which occur in the depth and locality of the channels are incessant. The banks too are continually under-going change through the action of the water undermining them at one place, and forming new banks at another. Flats or shallows intervene with deep narrow channels throughout the greater part of its course; and when the river is low, small shallow channels or runs are formed through or across the flats or sand-bars; and in one of these channels frequently is to be found the only passage for the navigation. The width of the river is so various that it is impossible to give more than an idea of it. When low, it is from $\frac{1}{4}$ mile to $1\frac{1}{4}$ mile; when high, from 1 to 3 miles, and in some places it extends over 20 or 30 miles of the flat country. The subjoined sketch is an exact representation of a part of the Ganges, taken at rather a favourable place, and showing the river when low. (Plate I.) The depth, when high, is in the channels between 35 and 75 feet; and when low, between $3\frac{1}{2}$ and 10 feet. The perpendicular rise of water in the wet season at Jellinghee is about 32 feet. The Bhaugruttee, though called a river, is a side channel or mouth of the Ganges, and through which the navigation is performed in the high-water season: the width varies from a furlong to a quarter of a mile, and during the navigable season the least depth is from 3 feet to 22 feet. For some months of the year it is not navigable for large vessels. The Hooghly, which is a continuation of the Bhaugruttee, and through which the navigation is continued to Calcutta, although resembling in its general features the great Ganges, is less irregular and of easier

Plate 1

Sketch of a part of the RIVER GANGES 1841.



A. Ro

London, John Weale, 59, High Holborn, 1848.

navigation; its depth is generally greater than the Ganges, and the width of the channel is satisfactory: at Calcutta, where it is a tidal river, it is nearly as wide as the Thames at Gravesend. The Soonderbunds, through which the navigation to Calcutta has to pass in the low-water season, are, in fact, small mouths of the Ganges, flowing to the sea through a delta of fine sandy alluvial deposit, covered with a rank vegetation and jungle. These channels are very numerous, and reticulate with each other in the most extraordinary manner, like a labyrinth. Their width varies from only 50 feet to ¼ mile, and being within the tidal action, their depth is much the same at all seasons of the year; and at low water is probably not less in the channels used by vessels than 5 feet: their chief peculiarity is their extreme crookedness and sharp bends.

THE SEASONS under whose influence the Ganges presents extremely different aspects are divisible, as respects the river, strictly into only two,—the *high-water* or inundation season, and the *low-water* or dry season: the latter is unfortunately of the greater duration, and extends over seven and half or eight months of the year,—say half of October, all November, December, January, February, March, April, and May, and sometimes half June;—the lowest months are April and May, and in the other months there is a gradual decrease and increase. The high-water or wet season takes place in the four and a half months of June, July, August, September, and part of October. The augmentation in the body of water is produced from two sources: 1st, the melting of the snows in the Hymalayan Mountains and elevated country, in which the Ganges and its tributaries, the Jumna, the Gogra, the Gunduck, &c., have their sources;—the water derived from the snows reaches the lower parts of the river by June:—and, 2nd, the rains which fall all over the great plain of the Ganges during the months of June, July, August, and September. By October the surplus water has been absorbed by the thirsty soil, evaporated into the burning atmosphere, or discharged into the sea; and the dry or low-water season sets in. From March to June, the hot season before the rains, 'Nor-westers' sometimes occur: these gales come on very suddenly, and blow with great violence for three or four hours, during which great destruction is caused among the native craft on the river. When the storm first commences, the dust and sand are carried up in such vast quantities, in some parts of the country, as completely to darken the air.

COURSE OF THE NAVIGATION.—The navigation of the Ganges between Allahabad and Calcutta is a most curious and interesting subject, about which a great deal might be written, but a very brief notice will suffice here. The appended Map of the river between the above points, and the Table of Distances, will serve to illustrate the subject.

The course of the navigation, starting from Allahabad downwards, follows the main stream of the Ganges at both seasons for a distance of 580 miles, to the point where the Bhaugruttee forms a separate channel.

In the high-water season, the navigation is then by way of the Bhaugruttee for a distance of 138 miles to Nudya, where it enters the Hooghly. In the Hooghly, its course down to Calcutta is 68 miles,—total 787 miles.

In the low-water season, instead of entering the Bhaugruttee as above, the course of the navigation continues its way down the main stream of the Ganges for a distance from Allahabad of 696 miles to the Goraee channel, which diverges to the right or south-westward; through the Goraee and the Barashee it pursues its course for 162 miles, till the delta of the Soonderbunds is reached. Through the crooked and many-named channels of the Soonderbunds it runs for 220 miles, till it unites with the Hooghly at Mud Point, *below* Calcutta. It then ascends the Hooghly to Calcutta by the Ship channel, 69 miles,—total, 1147 miles.

During the period of high water or inundation already mentioned, the navigation presents few difficulties beyond the force of the current to vessels ascending the river, which now averages a velocity of 4 miles an hour for the whole distance, and is frequently met running at 6 and 7 miles per hour, while at a few points its velocity reaches 8 miles an hour. This, although it would be of no moment to a powerful steamer, is a serious one to the native boats and to steamers not adapted to encounter such a current. The *descent* is of course facilitated by the current. At this season there is depth of water over the shallowed parts of the river for a vessel of almost any dimensions and draught. The Ganges is now a magnificent highway of traffic, worthy of one of the most populous and productive regions on the face of the globe.

For the greater part of the low-water or dry season, the Ganges is not navigable for vessels of much draught; as although in many intermediate distances between towns upon its banks there is ample depth of water, it is of course necessary in the '*through*' navigation that the vessel should pass over all the shoals and sand-bars: upon many of these the depth, as before stated, varies from only 3½ to 5 feet, and in a particularly dry season, during April and May, it may be found even under 3 feet. Now it is that the great difficulties of the navigation are experienced. From the changeableness of the shoals and channels, and the intricacy of the latter, vessels of every kind are in constant danger of running aground, and nothing but the greatest vigilance of the commander and pilot can keep a steamer from running upon the sand-banks, from whence she is dislodged with much exertion, and frequently after great loss of time. Native boats getting upon a bank or shoal at this season, and when the river happens to be falling, are sometimes, from the want of energy of the native character, left high and dry upon the sand by the water receding, where they remain till the next rainy season. In descending with the current, the liability of vessels to run aground is far greater than in going up stream, as the ripple caused by the bar or shoal does not discover itself so much upon the upper side as the lower side of the bar, and as the vessel's progress with the current is so much more rapid. When the ground is taken by a vessel coming down too, she is more difficult to get off, the chances being that she must be 'worked over' the bar or shoal in order to get her afloat again.

The velocity of the current of the Ganges is less at this period than during the rainy season, the average between Allahabad and Rajmahal probably not exceeding 2½ miles per hour. The only difficulties met with in navigating the Soonderbunds arise from the narrowness of the channel and the acuteness of the angles formed by it. These obstacles, however, apply only to steamers in turning the bends. The tide governs the current, which is sluggish, and of course alternately flows up from as well as down to the sea.

Notwithstanding all the impediments which nature has placed in the way of the navigation of the Ganges in the low-water or dry season, it is still even then available for carrying on the traffic of the country to an extent that the resources of science and capital would find it no easy task to provide a substitute for.

Traffic.—The traffic on the Ganges, could it be precisely stated, would probably appear exaggerated; but no means exist of ascertaining it with any approximation to exactness. A statement of the river tonnage arriving at or departing from Calcutta would give but a very limited view of the subject, (see Appendix C.),—leaving out, as it would do, the intermediate traffic between some of the principal cities and marts of India. The face of the broad stream may be seen sometimes covered with whole fleets of river craft.

At the Jungeepore toll, on the Bhaugruttee, the only point except Calcutta where there is any return made, the number of these vessels which passed was, in the year 1844,—50,320 boats, the tonnage of which was upwards of three quarters of a million tons. The articles enumerated consisted of grain, pulse, salt, sugar, indigo, cotton, saltpetre, oil, seeds, mangoes, vegetables, coals, lime, fire-wood, straw, &c., &c., &c. In the above, no account is taken of vessels with Government troops, stores, or ammunition, nor of opium.

The number of river craft arriving at Calcutta by the Soonderbund rivers, upon which toll was collected in 1844, amounted to 125,000 boats, or an average of 340 per day,—total tonnage of which is about a million and a quarter tons. The traffic at these two points alone added together (which it is fair to do) amount to upwards of 2,000,000 tons, or four times as much as the whole sea traffic in ships to and from

Calcutta: no account was taken of boats under the burthen of 28 maunds.

The returns from the Government Inland Steam Department, in the same year 1844, gave 39 voyages, carrying 45,500 packages of goods, besides treasure, and 2500 passengers, and show a return of upwards of £ 56,000.

From Mirzapore, a great mart in the Ganges, it is reckoned that 18,000 tons of cotton, 2000 tons of sugar, 1000 tons of saltpetre, 1500 tons of indigo, and 1300 tons of shell-lac and lac dye, are annually sent down to Calcutta; whilst there is received at Mirzapore from Calcutta, yearly, 8000 tons of metal and hardware, 5000 bales of twist, 3000 packages, British silk and cotton goods, and 10,000 packages of other piece goods.

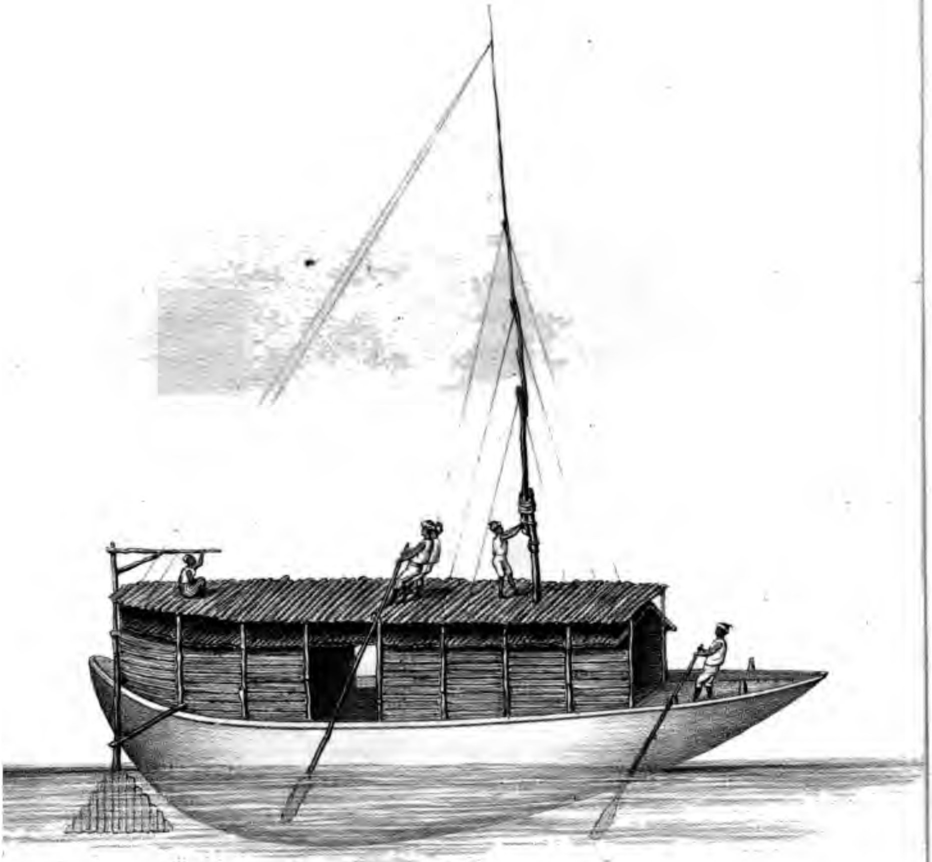
The far greater part of the enormous traffic on the Ganges is carried on by means of the native craft.

VESSELS NAVIGATING THE GANGES PRIOR TO THE INTRODUCTION OF THE NEW STEAMERS.

Native Boats—Government Steamers—Objections to the latter.

The Native Boat is a strange rudely constructed craft, something like the sketch (Plate II.), the roof thatched with bamboo and straw. These vessels are from 5 to 60 tons burthen, their length being from 25 to 90 feet, and beam 9 to 28 feet, with a draught of water of 18 inches to 5 feet. They are managed by a crew of six to twelve men, who allow them to drop lazily down the stream, perhaps with a little aid from a sail; and in ascending use the sail, the oar, or, when the wind fails, drag them with the track lines attached to the mast, the men walking along the bank of the river. They are generally very leaky, and the cargo almost always suffers more or less from the leakiness of the boat,

Pl. 2



del

Day & Son lith^{rs} to the Queen

NATIVE BOAT ON THE GANGES RIVER.

Length 50 Feet

the imperfect protection from the weather afforded by the roof, or the dishonesty of the crew.

They *descend* from Allahabad to Calcutta, a distance by the river of 800 miles, in about twenty days during the wet season, and from forty to sixty days during the dry season, stopping generally at night. The ascent is a very different affair, occupying from three to four months at all seasons. The lighter class of boats do it in about one-fourth less the time. They are subject to such casualties as getting aground, being wrecked and sunk by the 'north-westers,' oversetting in the rushes of the river from mismanagement in tracking them up, and to the thatch roof taking fire and destroying the cargo. These are the vessels by which the Ganges has been navigated from time immemorial, and no improvement would appear to have taken place in them. Previous to the introduction of European commerce, and when the articles requiring to be transported were of a less valuable, and some of them of a less perishable nature, they answered every purpose: since that event, the requirements of the traffic have changed considerably, and experience has proved that notwithstanding the low first cost of the native boats, and the small expense of navigating them, and consequently the low rate of freight, the conveyance of goods up the Ganges by them is both expensive and unsatisfactory; while that of such produce downwards as indigo, sugar, and cotton, although less so, is still greatly and justly complained of. The losses by peculation have been continually on the increase of late years, and the aggregate of this alone must be enormous, whilst the uncertainty and irregularity of arrival is such as to set at naught any commercial calculation. Passengers are also conveyed by native boats named 'budgerows:' these are principally used by the Europeans and the rich natives, and are comparatively few in number. They take nearly the same time to perform the voyage as the lighter freight-boats.

INDIAN GOVERNMENT STEAMERS.—The shortcomings of the native boat navigation were so great and manifest, and the advantages of a quicker and more certain transit for goods, passengers, and troops were so clear, that the Honorable East India Company, with their usual zeal for the improvement of the country, very early sanctioned the introduction of steam boats on the Ganges. Captain Johnston, the present Comptroller of Government steam vessels at Calcutta, and Mr. Peacock, of the India House in London, took an active part in this matter. Captain Johnston brought the first steamer ever seen in India round the Cape, named the *Enterprise*, and afterwards organized the Government line of steam boats on the Ganges.

Under the administration of Lord William Bentinck, in 1834, the steam traffic of the river was greatly developed by the establishment of a regular line of steamers for the conveyance of Government stores, troops, passengers, and merchandize. But although the Government of India thus led the way, it was understood that it was not intended to discourage or restrict private enterprise.

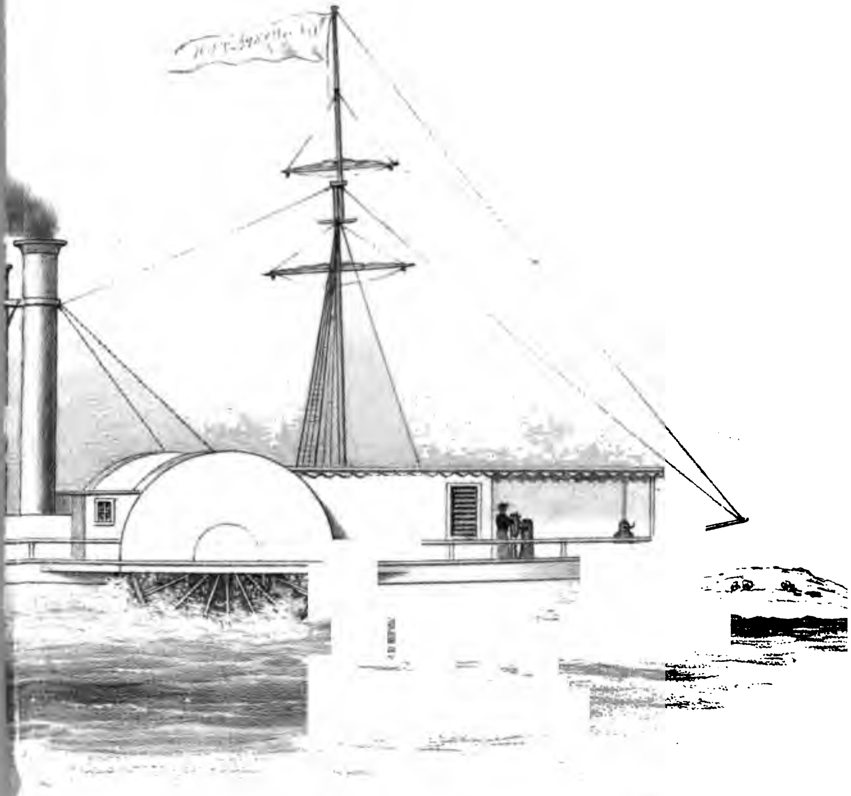
Fortunately for the advent of Steam Navigation in India, *coal* had then been discovered in several places; and at Burdwan, 63 miles from Calcutta, mines had been opened and worked. This coal is, however, not as good as British coal, the estimation being that it is only equal to 75 per cent. of Newcastle coal; but it is highly probable that as the pits are deepened the quality will improve. The Burdwan coal is now brought to Calcutta by the Damoodie river, at a cost of 20 shillings per ton, and to other places on the river at prices varying from 18 to 27 shillings per ton. The price of English coals at Calcutta is from 30 to 33 shillings per ton.

The system of steam navigation introduced by the Indian Government, and which is continued to the present time, is that of placing the goods or passengers in small separate vessels, and the steam engine and coals in another, which tugs or tows the cargo-boat or passenger-boat, as the case may be. The steamers or 'steam-tugs' are generally of iron, and about 120 feet long, 22 breadth of beam, 8 feet deep, and draw, when fully coaled, from 3 to 4 feet water. The engines are of from 40 to 90 nominal horses' power, and of excellent workmanship. The steamers are in fact similar to what were used on the Thames a few years ago, only shallower, and of fuller build. The vessel in which the passengers are placed is termed an '*accommodation-boat.*' It is of similar dimensions with the steam-tug, and is fitted up with passengers' cabins, and a 'cuddy' athwartships dividing them; it carries only passengers and specie, and light packages and parcels. The freight-boat or '*flat*' is also of the same dimensions as the steam-tug, viz. 120 feet long and 22 feet beam, and draws, when loaded, about 3 feet; it has cabins for the captain and ship's officers only, and takes no passengers.

One only of these vessels is tugged or drawn by the steamer at a time, so that the freight and the passengers are never conveyed together by the same steamer.

The twin vessels are linked to each other at the bows and stern by a flat beam of wood, which acts as a hinge, and serves also the purpose of a plank for the crew to pass from one vessel to the other: the subjoined sketch (Plate III.) represents a steamer with 'accommodation-boat' in tow. When this system was introduced in India, there existed no examples in this country of steamers carrying *cargo* upon a *light draught of water;* and as carrying power was a *sine quâ non* in the Ganges, the plan adopted of double vessels was a very natural one. Besides, it seemed to present other advantages, such as the following: "In case of getting aground, it would be easier to get off two small vessels than a large one;—in the sharp turns or bends of the Soonderbunds, they could more easily wind their way through them than a long vessel, &c.;—the goods and passengers would be safer and cooler

Pl. 3.



Day & Son lith^rs to the Queen.

N IT

Length of Steam Tug. 120 ft
Breadth of D^o . . 22 „
Horse Power. 90.

in a separate vessel." The freight-carrying power of the cargo-boat or flat is not, however, very considerable: the range is between 60 and 100 tons of dead weight, varying with the season or depth of the river. This *weight* of measurement goods (that is, of articles the bulk of a ton weight of which exceeds 40 cubic feet) will of course make a great deal more 'tonnage' upon which freight is chargeable. The capacity of the accommodation-boat for passengers, owing to the large space deemed necessary for a cabin passenger in India, is somewhat limited; the average being cabins for sixteen passengers, with their servants, &c.

The steamer or tug and the vessels for freight and passengers *have each their own captain, officers, and crew;* and the steamer has of course, in addition, its engineers, stokers, &c.

The speed of the Government double steamers varies considerably, those of recent construction being the fastest. With an average cargo and the usual coals on board, the velocity of the slower ones through still water is probably 6½ miles per hour; that of the faster, 7½ miles per hour. When going with the stream, the velocity of the current is of course to be added; and when going against it, to be deducted from the velocity through still water: thus in a current of 4 miles an hour, it would be 11½ miles in one case, and 3½ in another. The time in which they make the passage between Calcutta and Allahabad may, from the sketch of the nature of the navigation given in the preceding pages, easily be conceived to vary greatly; it is, moreover, further varied by the degree of attention and skill of the captains. Like the native boats, steamers are obliged to stop running during the dark of night. In the dry season, the average passage up is twenty-four days, and down fifteen days. In the rains, the average passage up is twenty days, and down eight days. This would give a rate of progress per day, during the dry season, of 50 miles per day on the upward passage, and 80 miles per day upon the downward passage; and in the rains, of 40 miles and 100 miles. The number of voyages made annually by each steamer is nearly six. In 1844, there were seven Government steamers, with their accompanying vessels, all of which were kept in activity. This number has since been increased by two more, specially adapted for troops. The rate of freight charged to the public for goods upwards depended upon the tonnage to spare after the wants of the Government were supplied, and upon the demand; and as these two circumstances were constantly varying, the expedient of putting the spare tonnage up to auction was resorted to, as the only fair way of distributing it. The minimum rate was, in 1844, for measurement goods, 3*s.* per foot, or £ 6 per ton of 40 cubic feet; and for dead weight goods, £ 14 per ton of 20 cwts. The rate actually bid at auction, however, often went as high as £ 20 per ton measurement!

The rate for passengers was fixed at £ 30 per cabin passenger for the whole distance, not including provisions, the passenger providing his own bedstead and bedding, according to the custom of India.

The earnings of the Government steamers were, as may be supposed, very considerable; and it is understood they have paid their cost many times over. They have unquestionably answered well in many respects, and fulfilled the main objects of the Government of India. The Indian public therefore owe a debt of gratitude to Captain Johnston and to the Honorable East India Company, for introducing *steam* navigation upon the Ganges, which otherwise would not probably yet have been done by private parties; while to Captain Johnston and the other officers entrusted with the management, a large meed of honorable praise is due for the ability displayed in their arrangements, and their great zeal and attention to their duties.

Having thus noticed briefly the system and actual state of steam navigation on the Ganges in 1844, and shown the great step in advance it formed upon the native boat navigation, its objectionable features, as they appeared to the writer, remain to be stated.

As to the question of the desirableness of the Government keeping up a steam flotilla on the Ganges for the conveyance of troops, military stores, and treasure, it will be at once conceded, that to carry on the general steam traffic is not the proper business of the Government. From what has been stated, it is indeed obvious that the field is far too extensive for the Government to attempt to occupy it.

Objections to the Double Vessel System.—1. The first thing that will doubtless strike any one accustomed to steam navigation in any other part of the world, in the preceding account of that existing upon the Ganges in 1844, is the slowness of the performance of the steamers. Fifteen days taken for doing a distance of 800 miles *with the stream*, that is, 80 miles per day,—and twenty-four days against the stream, or 50 miles per day,—must appear incredibly slow; and notwithstanding the difficulties of the Ganges, it seemed to the writer far below what was practicable. Their deficiency of speed as steamers does not indeed admit of a question. Now setting aside the inconvenience and loss to the public arising from the detention of passengers and goods, it must be borne in mind that the number of voyages per annum depends upon the time in which one voyage is made; and as the cost of capital and expenses of running the steamer are the same, whether few or many voyages are performed in a year, the profits are directly and largely affected by the want of speed in the double vessel system.

2. The double vessel or tug system is wasteful of power; the resistance of water to vessels propelled through it is chiefly at the bows and stern, and not much at the sides of a vessel, where it is only that due to simple friction. There is consequently far more resistance than there would be in a single vessel of the capacity of the two. Now as wastefulness of *power* is the same thing as waste of fuel, and as that

is the chief expense in all steamers, and emphatically so in India, this is a weighty objection.

3. The force of the current in the Ganges, as already observed, varies greatly from place to place, setting down round the points in the bends of the river in a rush of 6 or 8 miles per hour, while below the points the current may be running only 2 or 3 miles an hour, or there may even be a counter current or eddy setting upwards. When the double vessels meet these unequal or opposite currents, they frequently become unmanageable, in spite of the greatest exertions of the helmsmen and crew of each vessel, fall foul of each other, and are driven, at the mercy of the current, sometimes a distance of four or five miles down again before they can recover themselves. At some of the 'rushes' of the river round the points during the high-water season, they are unable to pass up without the further aid to the machinery of bullocks and men, tracking along the shore with lines attached to the steamer.

4. As to the presumed necessity for short vessels in the Soonderbunds, it did not appear to the writer to exist; and the double vessels, owing to the impossibility of steering them with precision in such places, notwithstanding their shortness, frequently strike against the bank in the sharp turns of the Soonderbund channels.

5. The advantages of the separation of the passenger vessel or 'accommodation-boat' from the steamer, is probably in some measure counterbalanced by its

being close *behind*, and receiving some of the products of combustion from the funnel of the steamer, and the heat of the engines.

6. In the rainy or high-water season, as has been shown, there is plenty of depth in every part of the Ganges, and it would be then very desirable to be able to load a large extra cargo; but the freight vessels in question, from their small size, admit of this to a small extent only.

7. The expense of maintaining a nearly double personal establishment of captain, officers, and crew, which appears to be necessary upon the double vessel system, is a considerable item.

INTRODUCTION OF THE NEW SYSTEM OF STEAM NAVIGATION.

Up to 1844, no attempt had been made by private parties to follow the example set by the East India Company, and the navigation of the Ganges by native river boats and the steamers of the Government of India remained such as has been described. In that year the writer arrived in India, and, after the examination of the subject referred to, and communicating his views to his friends, a Company was formed for establishing and running a line of iron steamers upon his plans for conveying freight and passengers between Calcutta and Allahabad or Mirzapore, and to which was given the name of the 'Ganges Steam Navigation Company.'*

The Ganges Company decided to order three steamers in the first instance, but shortly afterwards increased the number to five, and entrusted the writer's firm to supply them. The views which guided him in laying down the design of the new steamers were these:

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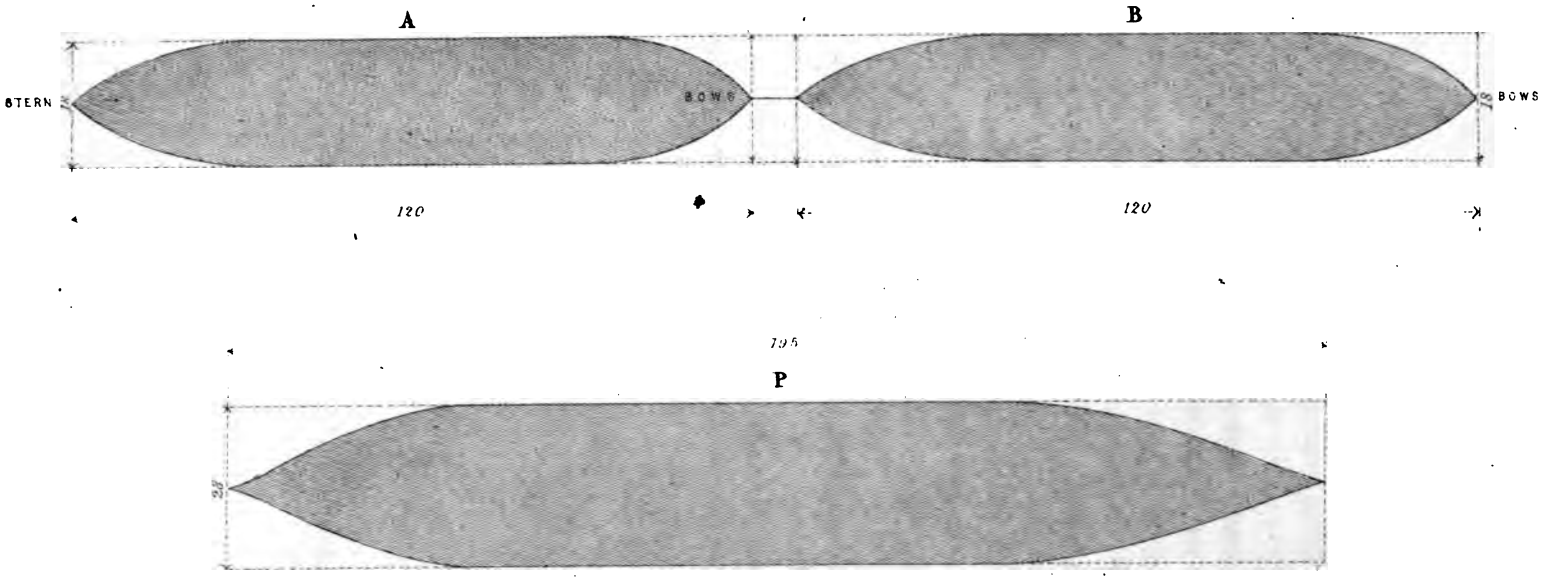
* The agitation of the question about the same time by other parties had the effect of drawing the attention of some of the

1st. That the time required by Government steamers for performing the distance was excessive, and that it should be done in one-half the time, in order to develope fully the advantages of Steam Navigation;—consequently, that higher speed was necessary for the new steamers.

2nd. That the speed was not attainable upon the double vessel or tug system; and consequently, that the engines and cargo should go into a single vessel of adequate size and suitable form.

3rd. That the single vessel system is more economical of power than the double vessel or tug system; that is to say, a single steamer, capable of carrying a weight of 100 tons, will not require as many horses' power to propel it at any given speed as two vessels carrying between them 100 tons.

Calcutta merchants to the subject, who got up another steam boat company, raised a capital, and ordered their steamers from London. It was named the '*General Inland Steam Navigation Company*,' and is perfectly distinct from the association whose steamers form the subject of this Paper. This Company's steamers are upon the tug system, but differ from those of the Government in being of greater power, and being intended to tug or tow *two* small cargo vessels at once, the passenger cabins being on board the steamer. The names of those which have been put on the line are, the *Sir Herbert Maddock*, the *General M^c Leod*, and the *Sir Frederick Currie;* the second of these was, however, unfortunately lost in the Hooghly, and the Company have recently purchased the Assam Tea Company's steamer, *Assam*.



A. Robinson Del.

Day & Son lith^rs to the Queen.

London, John Weale, 59 High Holborn.

The application of this natural law to the case, according to the best received authorities* upon the subject of the resistance of water to vessels propelled through it, would be as follows: A and B (see Plate IV.) are two vessels of the form of the Indian Government steam tug and the carrying vessel drawn by it. At the velocity of 8 miles an hour, the actual resistance of the water to both vessels is 5640 lbs., which requires the power of 113 horses to overcome it.

P is a single vessel whose area of water-line and carrying power is equal to A and B; the resistance of the water at 8 miles an hour to P is 3500 lbs., which requires only 70 horses' power. Thus there is an economy of power of 43 horses by the single vessel, equal to 38 per cent.

4th. That the greater length and breadth of vessel or larger area thus requisite *could* navigate the Soonderbunds, *could* be made manageable under the difficulties of the river, and *could* be constructed of suitable strength and lightness of draught.

5th. That in the same measure that the time of the voyage is shortened, the number of voyages in a year are increased. You either then augment the profits, or can lower the rate for carrying freight and passengers with an equal profit, and a corresponding benefit to the public.

6th. That a single large and powerful steamer could take a heavy *extra* cargo during the rainy season of four months annually, when there is ample depth of water in every part of the river.

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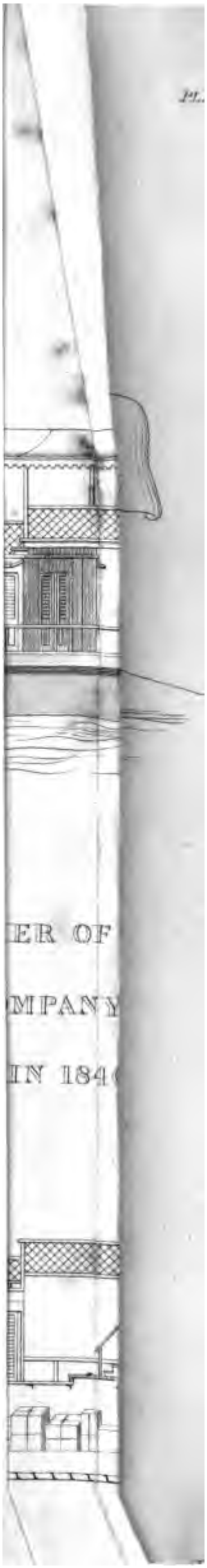
* Mr. Scott Russell and Colonel Beaufoy.

7th. That as respects passengers, by placing the passenger cabins upon deck, and 'forward' of the machinery and funnel, little annoyance or heat from that source would be experienced.

In conformity with these views, it was determined that the first two of the new steamers should be adapted *both for cargo and passengers,* and have condensing engines; and the three others for cargo or freight only, with non-condensing engines; and that the design and arrangement should be as will be now described.

Pl.



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DESCRIPTION OF THE FIRST TWO OF THE NEW STEAMERS.

General Plan — The Vessel — The Engines — The Cabins—Mode of Construction and Transport to India.

The following is a general specification or description of the first steamer, named the *Patna*, as actually constructed, and the second, named the *Benares*, is identical with the *Patna*.

General Arrangement of Vessel, Engines, and Cabins.—The hull below the main deck is appropriated to cargo, with the exception of the space occupied by the boilers, and the condensers and air-pumps of the engines. The main deck projects over the sides all round, tapering in at the bows, forming 'guards' which increase the room on deck. The engine cylinders lie horizontally on the main deck. The saloon and cabins are also placed upon it, 'forward' of the engines and boilers.—

Over the cabins, and extending nearly to the stern, is a light promenade deck, and the part of it for cabin passengers is covered by an awning. See Plate V.

MATERIALS.—The frame and deck beams and paddle-box frames are of *iron*, and the shell of *iron plates*. The main deck is of wood. The cabins and the promenade deck over are entirely of wood.

The length is, at load water line, 195 feet.

The beam or breadth of hull is 28 feet.

The extreme breadth over paddles is 46 feet 9 inches.

The depth of iron hull is 10 feet 3 inches at the engine-room;

And the rest of the hull, 7 feet 9 inches.

The bottom or floor is nearly flat, rising on each side only sufficient to throw the bilge-water towards the keel. The bows are full, but with a good and fine entrance. The stern is as full as was considered admissible, and is in character with the bows.

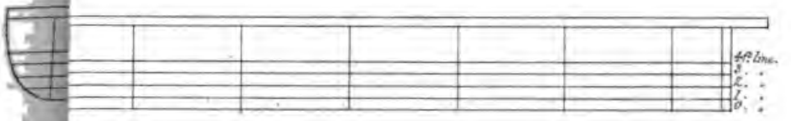
The mean angle subtended by the bows is 32 degrees;

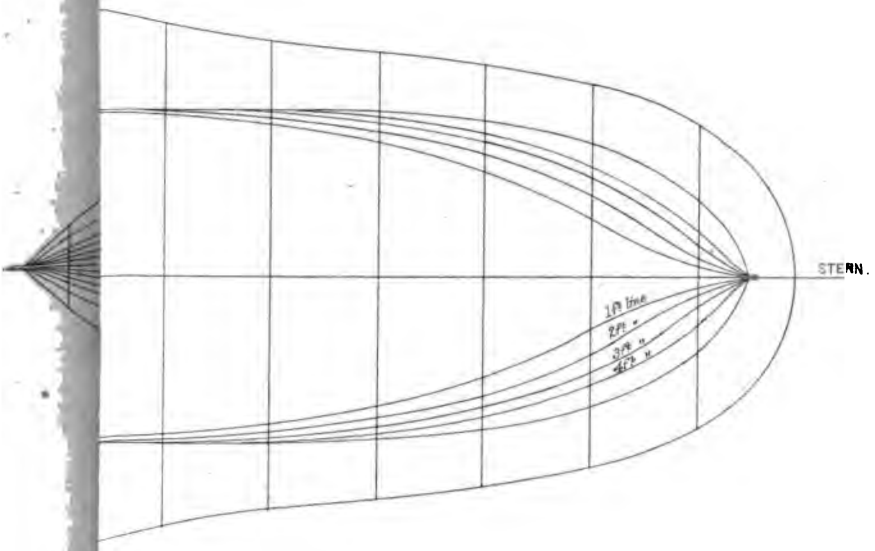
And by the stern, 54 degrees.

The 'parallel body,' or midship, without curves, is one-third of the length of the vessel. A 'builders' draught' of the hull is shown in Plate VI.

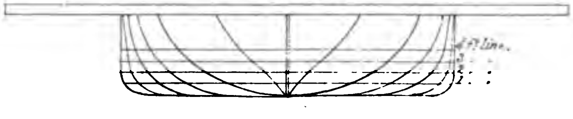
The tonnage of the hull, exclusive of cabins and upper deck, builders' measurement, is 400 tons.

The entire cubic contents of the interior of the





CROSS SECTIONS AT EACH 9 FEET,
STERN.



Day & Son, Lith^rs to the Queen.

hull is 38,434 cubic feet. The machinery and coals occupy a space of 12,800 cubic feet, leaving for cargo a space of 25,634 cubic feet, or 641 tons measurement.

The 'displacement,' or cubic contents of the immersed body or hull, and the weight of water displaced, or *carrying power* of the vessel, is, at each 6 inches draught, from 2 to 4½ feet, as follows:

At 2	feet	0	inches,	12,812	cubic feet	= 205	tons.
2	,,	6	,,	16,625	,,	= 266	,,
3	,,	0	,,	20,500	,,	= 328	,,
3	,,	6	,,	24,438	,,	= 391	,,
4	,,	0	,,	28,437	,,	= 455	,,
4	,,	6	,,	32,437	,,	= 519	,,

The details of the construction of the iron and woodwork are not considered of sufficient general interest to state the whole of them in this Paper: it will suffice to point out the peculiarities. There is no external keel; it is replaced by an internal one, or keelson, formed of a light hollow iron beam, 2 feet deep and 9 inches wide, and which is riveted to the inner frames of the bottom of the floor. Between this keelson and the iron deck beams, and riveted at their upper and lower ends to both, are light stiff stanchions of iron, which have the effect of both trusses and ties, binding the floor and deck together. The sides of the vessel are vertical, and the iron frames which run up to form them finish at the gunwale in a strong cornice, formed of angle iron and a narrow plate. The heads of the frames, the upper edge of the top strake of plate, and the ends of the iron deck beams, are thus all riveted together. The powerful connection by this means formed between the bottom or floor and the deck, both by the sides of the vessel and the midship trussing, constitute the entire hull into one large hollow iron beam. The sides themselves are, for the third of the vessel's length amidships, strengthened by diagonal ties, crossing the ribs or frames at an angle of 45 degrees, and riveted to each rib. All the iron in the frame, flooring, and shell, is of light scantling, but of a quality and make giving the greatest tenacity and strength.

The paddle-boxes are built upon the ends of two light hollow iron beams, which cross the vessel under the deck and project beyond the sides for the purpose, as well as for supporting the engine bearers, which shall be described with the engines. The paddle-boxes are framed of angle iron.

The rudder is 12 feet broad, and is worked from a point at the back, instead of by a tiller.

The rudder chains lead to a steering wheel placed near the bows upon the upper deck, from which position the helmsman and pilot command a view of the river and of the best course.

The deck plank and covering of paddle-boxes are of teak wood, the former being only 1⅝ inch thick; they are fastened to the deck beams and framing of paddle-boxes by wood screws.

The entire weight of the vessel with paddle-boxes, and exclusive of machinery, cabins, and stores, is 142 tons.*

Steam Engines.—The engines are medium-pressure condensing, unconnected, and of the nominal power of 120 horses. The cylinders are two in number and are horizontal, are of 30 inches diameter, and the stroke is 7 feet. The boilers supply steam of an elasticity of 20 lbs. pressure per inch above the atmosphere. The steam is worked expansively. The speed of the piston is 280 feet per minute. Each engine has a separate condenser of large size, and an air-pump worked by a bell-crank

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* *The following are the remarks of an Indian newspaper of the 10th April,* 1846, *upon the new system:*

"The New Steamer, the 'Patna.'—We have been favoured with a lithographed drawing of the new steamer, the *Patna*, constructed for the Ganges Steam Navigation Company, which their engineers are now putting together in Calcutta, and which may be expected shortly to be placed on the line between that city and Allahabad. It bears a closer resemblance than any of our present steamers to the steam vessels employed on the rivers of America, where the art of river steamers has attained the same perfection which that of sea-going steamers has reached in England. The essential difference between this vessel and the Government vessels now plying on this line consists in the union of the steamer and the flat, in the same block. The adoption of the double vessel was enforced by the supposed difficulty, or rather, the impossibility, of threading the narrow and intricate channels of the Soonderbunds with a single vessel of sufficient length. We understand that the Soonderbunds have been carefully surveyed by the engineers of the Ganges Company, and they have found no obstacles to the successful navigation of single motion taken from the cross-head: they are placed upon the floor of the vessel under the cylinders. The diameter of air-pump is 2 feet 4 inches, and the stroke 2 feet 6 inches. The vacuum kept up in condenser, with water of the temperature of 80°, is 28 inches on the barometer. The *mean effective pressure* upon each square inch of the piston resulting from both the pressure of the steam and the vacuum is, when the steam is cut off at ⅔rds the stroke, 27 inches per indicator.

Each steam cylinder, with the parallel guides of its piston-rod and main crank-shaft bearing, are attached to and carried by two hollow iron beams, placed

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vessels of as great length as those which they are constructing. This question has been so warmly debated between those who entertain opposite opinions, as to have become almost a party question. A few months will now bring it to a satisfactory issue, founded on the result of experience.

"We look with no little interest at the progress of an enterprise which promises to abridge by nearly two-thirds the time now occupied in the journey between Calcutta and Allahabad. We may not only expect a great saving of time, which is an important point even in India, but more particularly a great reduction of expense arising out of the saving of time. We shall now have an opportunity of ascertaining the value of those opinions to which it is owing that no improvement has been made in our river steam navigation in the past eleven years, during which time the most backward countries of the civilized world have been making the most remarkable progress. We shall now have that healthful and invigorating competition without which all improvement is hopeless; and we are certain that the community in India will hail this rivalry with no little satisfaction, because, in the absence of it, every change hitherto has only been from bad to worse, from slow to slower, from dirty to dirtier."

longitudinally at the level of the deck. These engine-bearer beams are riveted to the cross paddle-beams of the vessel before mentioned, and the deck is connected to them; thus the deck itself is made a part of frame of the engine, and the engine-bearer beams add to the strength of the vessel.

The steam-valves are upon the long D-slide principle, and, packed in the usual manner, are actuated by an excentric on the crank-shaft. The reversal of the engine is performed by a separate excentric—the ends of the connecting rods of the two excentrics are attached to a '*link*,' the '*slot*' of which moves up and down upon the '*pin*' in the lever of the valve-shaft. The link is 'handed' by means of a hand-wheel, toothed pinion, and toothed sector. When the *link* is down, the valve is worked to turn the paddles the right way, and the steamer goes 'ahead;'—when up, it reverses the paddles, and the vessel goes backwards;—and when between the two or half-up, the action of the valve is stopped, and consequently the engine and vessel also.

The vacuum is governed in the usual manner by shutting off or opening the injection-cock which regulates the flow of the water into the condenser, and as a consequence the vacuum also.

There is a separate expansion steam-valve worked by a three-grade camb upon the crank-shaft, by regulating which according to the circumstances, the steam is cut off from further entry into the cylinder at $\frac{3}{6}$ths, $\frac{4}{6}$ths, or $\frac{5}{6}$ths of the full stroke.

The Boilers, four in number, [illegible] single-storied and tubular. The external shell of each is curved at the fire-boxes, and cylindrical at the tubes.

The grates or furnaces are adapted for either wood or inferior coal.

The surface upon which the fire acts by contact of fuel and radiation of heat is in each boiler of the superficial area of 78 feet; and by flame or hot gases in the tubes, &c., 524 feet, forming together 602 feet in each boiler, and an aggregate of 2468 feet of heating surface in the four boilers.

Propellers or Paddles.—Each engine actuates, independently of the other, a plain paddle-wheel propeller of 21 feet diameter, the breadth of which is 8 feet; the paddle-boards are made to 'reef' in, and are 20 inches broad. The immersion of the paddle-wheel is generally 2 feet 6 inches. The revolutions per minute are, when the steamer is light, 20; and when loaded, 18,—giving a velocity, at the centre of effort, of 14¼ miles and 13 miles per hour respectively.

The entire weight of the engines, boilers, propelling machinery, and engine bearers, is 106 tons.

The design of the engines, boilers, &c., will be better understood by the subjoined sketch of the engine-room, Plate VII.

It will be observed that the main features of this arrangement of the machinery are as follows:

1. The engines are combined with the vessel in

a mode that adds to the strength of the latter; the deck and engine frames being united by the most secure of all fastenings—iron rivets.

2. The weight of the engines is distributed over a large surface of the vessel, without increasing the space occupied by engines, boilers, and stoke-pit, in the ordinary marine engine.

3. The long stroke of the engines enables them to turn the centre freely, and to be worked without being connected with each other.

4. The engines are thus made effective in governing or steering the vessel, as one of them may be stopped whilst the other is moving onwards; or the engines may be made to move in opposite directions, and of course to turn the vessel right round in her own length.

The relation to each other of some of the more important points is expressed by the following summary.

Ratio of length to breadth . . .	as	7	to	1
Ratio of area of line of flotation to area of cross section, in feet	as	55·4	to	1
Ratio of length to depth	as	22	to	1
Ratio of cubic contents of immersed body to a parallelogram of the dimensions of outside of hull	as	0·71	to	1
Ratio of weight of vessel decked, and without engines or cabins, in tons, to the register tonnage (builders' measurement) . .	as	1	to	5·1
Ratio of actual power, in horses, to immersed cross sectional area, in feet	as	4·7	to	1

Ratio of area of fire surface in boilers, in feet, to area of immersed cross section, in feet, at mean draught	as	1·2	to 1
Ratio of area of 2 float boards to area of cross section immersed, at mean draught	as	1	to 2·53

Cabins.—The saloon and cabins for first-class passengers occupy an area upon the main deck forward of the engines, 54 feet by 32 feet, and stand 8 feet high: the saloon is 40 feet by 15 feet, and is placed lengthwise, the end opening towards the bows. There are 12 private passenger cabins, averaging 9 feet by 7 feet 6 inches. The promenade deck over the cabins is continued over the engine cylinders, and to near the stern; under it also is the captain's, the officers' and engineer's cabins, and a large space for light goods or carriages, horses, and deck passengers. The entire weight of the cabins and promenade deck is 12 tons.

The power of the engine is made available for hauling off the steamer when she grounds upon the sand-banks or shoals by the very simple contrivance of a 'whelp' barrel, similar to that of the windlass, securely put upon the main crank-shaft of the engine, where it crosses the deck. The chain cable, which is connected at one end to the anchor, laid out sternward or 'abaft,' is by the other end wound round the whelp barrel; the engine is then started, and exerts such a prodigious force that the vessel is speedily drawn off the sand-bank and afloat again.

Upon the considerations that these two steamers were

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to carry passengers,—were to be of great length in proportion to depth,—that they were to be propelled by powerful engines for vessels of such a construction,—that they must often unavoidably run aground at full speed, accelerated by the current of the Ganges,—that the engines too must necessarily be severely tried by the paddles working in sand or against a bank,—it was deemed better to err a little on the safe side of strength, at the expense of greater weight of both vessel and engines, and less carrying power in the steamer, than to obtain the highest amount of carrying power at the risk of the safety of the passengers, the loss of the steamer, or of her engines breaking down. As a measure of prudence, therefore, *the first two* steamers were made stronger both in the vessel and engines, and consequently weightier and of *greater draught* of water than the writer originally contemplated, and than may probably, after an experience of some years, be found requisite.

The weight of the vessel and paddle-boxes has been stated to be 142 tons—the engines, boilers, and propelling machinery and engine bearers, 106 tons—and the cabins and upper deck, 12 tons,—making a total of 260 tons. In addition there is to be taken into calculation the water in boilers, 21 tons; fuel for 12 hours' steaming, 10 tons; sundries, furniture, stores, &c., 15 tons,—making the working weight 306 tons. This weight requires an equal displacement, and which is obtained by an immersion of the hull to 2 feet 10 inches. All above this will be the carrying power for cargo. Thus at 3 feet 6 inches she carries 85 tons; at 4 feet, 149 tons; and at 4 feet 6 inches, 213 tons 'dead weight' of cargo. The carrying power for cargo is of course diminished by the passenger carrying accommodation to the extent of the weight of the cabins and stores, shown above to be 27 tons; and without these the working draught of the steamer would be only a fraction above 2 feet 7 inches.

MODE OF CONSTRUCTION.—Having now described in general terms the two first of the new steamers as they were constructed and started upon the Ganges, it may be of some interest, before entering upon the results of their operations, to refer to the mode of construction.

The iron vessel and the engines, which together form one of these steamers, are both designed in all their details by the same firm, who, being *Iron* Shipbuilders as well as Engineers, were enabled to produce a combination of the nature described. Each vessel and pair of engines were constructed simultaneously at their establishment; and when completed, the engines were fitted on board the vessel on the stocks; every thing was put in place, and the engines worked, to make sure that there would be nothing to fit or do to them abroad. The parts of the engines where they were joined to each other and to the iron vessel were then marked, taken asunder, and packed up for the voyage. The whole work of the vessel was then painted in the inside four different colours, each quarter being of one colour; and the plates of the shell and the ribs, as well as every piece, were marked with paint, and stamped with letters and numbers, to facilitate and insure the correct putting together in India. The vessel was then taken in pieces, and the whole carefully shipped and stowed on board a ship of the ordinary size, bound for Calcutta. Accompanying the parts was sent accurate drawings of the whole, and a model of the vessel, painted and marked exactly like the original. Upon arrival after only a four months' voyage, the parts were landed at the establishment of the 'Ganges Steam Navigation Company,' near Calcutta, the iron vessel put together in a dry dock, decked, and floated out. The work was performed chiefly by native mechanics, under the superintendence of the writer; and the first steamer was put together in only nine weeks from the day of landing. The engines were then fitted in, and the cabins put up, of teak wood, to the working drawings. The whole was completely finished and the steamer fitted out and started on the trial trip in a little more than four months.*

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* *The 'Englishman' Calcutta newspaper thus notices the launch:*

"LAUNCH OF THE 'PATNA.'—The Ganges Steam Navigation Company launched the first of its vessels recently arrived in this country, named the Steamer *Patna*, on Saturday evening, off Howrah Ghaut. The occasion was not marked by any of the usual ceremonies, and the company consisted of only a few gentlemen; but the launch was not the less successful. The steamer was easily drawn into the water, and glided gracefully midway across. Her construction is equally large and elegant; and the arrangements within are upon a plan excellently adapted to the comfort and convenience of passengers."

The 'Friend of India' newspaper of 2nd *July*, 1846, *thus records the fact, and has the following remarks:*

"The next day, the *Patna* steamer, the first vessel of the Ganges Steam Navigation Company, was launched without noise or parade. A few gentlemen, we are told, attended to see her 'hauled out of dock,' and she glided cheerfully in her own element. She is the most magnificent river steamer ever launched in India, and has been put together in the short period of two months and five days. This vessel is the first of a series of four steamers, built by Messrs. H. O. and A. Robinson and Co., Engineers, Millwall Iron Works, London, with whom the construction of vessels of this description for the rivers of India originated, and by whom the engines have been manufactured. We may shortly expect, therefore, to be able to test the merits of the two plans; the one, that of combining the steamer and the accommodations for freight and passengers in the same block; the other, that of employing the steamer in tugging two other vessels with cargo and passengers. The trial will not, however, be complete and decisive during the rains, while the river remains full, as the single vessel will, as a matter of course, enjoy a pre-eminent advantage over her encumbered rival. It is when both descriptions of vessels come to thread the narrow channels of the Soonderbunds, that the relative merits and efficiency of the plans will be definitively settled.

"The commencement of these improvements in our internal steam communication after a pause of nearly twelve years, during which we have seen the truth of the old adage exemplified, that not to advance is to go back, will form a new era in the history of steam in India. Under the competition of private enterprise, we may now look forward to an increase of speed, and to such a diminution of expense as shall place the luxury of steamers within reach of the community generally, and take up the commercial freight of the country."

TRIAL AND RESULTS OF THE TWO FIRST STEAMERS.

Trial Start and First Voyage of 'Patna'—Quick Voyage of 'Patna'—The 'Benares' First Voyage —Voyage in the Dry Season—Results.

THE 'PATNA.'—Upon trying the engines, they were found to work with even more smoothness than was anticipated; the cranks went over the centres freely, and the reversing, stopping, and starting of each engine separately was performed by the link motion with the greatest ease and promptitude. The boilers were found to generate steam enough with the Burdwan coals, and easy firing. There was no perceptible vibration in the vessel from the action of the engines. The time taken for a distance of 15 miles down the Hooghly, against the flood-tide, was 1 hour 34 minutes, and back again to the place of starting, *with* the tide, 1 hour 0·3 min. This is considerably more than 11 miles an hour. The trial by Massey's log showed 10¼ *knots* per hour, which is 11½ miles. The steamer was by the action of the engines made to turn round in her own length several times, in the presence of a great number of spectators. The steerage by the rudder was hardly as quick as was anticipated, but this was afterwards remedied.

First Voyage. — Upon the 28th of September, 1846, the *Patna* took on board upwards of 200 tons of measurement goods, 6 carriages, and 5 horses, reckoned to weigh 140 tons dead weight, 20 tons of coals, and 35 passengers,—total dead weight 164 tons. Her mean draught was then 4 feet 5 inches: this was a larger cargo than should have been taken upon a *first* trip with an inexperienced Captain, and at a period when the river was falling rapidly. The destination was Mirzapore, 706 miles above Calcutta and 86 below Allahabad. The river was then high with a strong current, so that the Soonderbunds were not resorted to, and the short passage by the Bhaugruttee was taken. The passage was, with the exception of grounding several times, performed most successfully,—the 'hauling-off gear' effecting at once the re-floating on every occasion but one, when, through mismanagement, the steamer stuck fast for three days. Notwithstanding this untoward event, the *Patna* reached Mirzapore on the 13th of October, or 15 days from Calcutta,* passing four Government steamers.

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* *The first trip is thus noticed by the 'Friend of India,' October 16th*, 1846:

"The 'Patna' Steamer.—The *Patna* arrived at Mirzapore

The *average* time of the Government steamers up, in the month of October, is stated officially at 22 days. (See Appendix A.)

The downward passage was performed between the 16th and 26th of October, via the dreaded Soonderbunds, and the entire voyage thus done within a month.

If this first voyage did not quite fulfil the expectations that had been formed as to *speed*, it had the effect of demonstrating that a steamer of this size and power, carrying her fuel, cargo, and passengers in one vessel, could navigate the Ganges and the Soonderbunds,—a fact which, until then, was generally believed impracticable in India.

The second voyage of the *Patna* was performed both up and down by the Soonderbunds, and without any incident beyond occasional grounding.*

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early on the 13th, fifteen days from Calcutta, and was to start on her return voyage on the 16th, so that she is due here on Thursday or Friday. The latter part of the voyage from Dinapore upwards was done in great style. From Benares to Mirzapore she was only 8½ hours, and from Ghazepore to Benares was done in one day's light, leaving in the morning and getting there the same day."

* *Extract from the 'Friend of India,' December*, 1846.

"The two trips which the *Patna* has now succeeded in making have served completely to banish the idea that its great length would prevent its making progress through the cork-screw windings of the Soonderbunds. This vessel, from the superior arrangement of its cabins, not less *than from its speed*, appears to be a favourite, if we may judge from the large batch of passengers who have just gone up in her. During the hot and sultry months of the year, she is sure to have a preference, because of the excel-

The *Patna* continued to perform successfully her voyages between Calcutta and Mirzapore, under the command of her first Captain, but did not attain the expected shortening of the time till the voyage commenced upon the 20th of June, 1847, under a *new* Commander. She then, with a full cargo on board, did the upward passage by the Soonderbunds route in 12 days, and the downward passage by the Bhaugruttee in 6½ days, and was only 20½ days absent from Calcutta.

This performance is recorded by one of the public journals thus:

> "We find that we were in error the other day when we assumed that the period of 20½ days in which the *Patna* steamer made her last trip to Mirzapore via the Soonderbunds and back through the Bhaugruttee included only the time spent on the actual passage. It included, we are now informed, the entire time of the vessel's absence from Calcutta, voyage, stoppages, detentions, every thing."—'*Bengal Hurkaru,*' 20*th July*, 1847.

The succeeding voyage of the *Patna* affords evidence to the same effect, as it was done in even still shorter time, viz. 19 days;—it is noticed by another recorder of passing events, as follows:

> "The *Patna* steamer has again made one of her usual rapid voyages to and from Mirzapore. The upward voyage occupied 11½ days, and the downward, excluding half a day's detention, 5 days. The distance is estimated at 730 miles. Including two and a half days in which she was detained, she has left Calcutta and returned to it in *nineteen* days, which is, we believe, the shortest voyage ever made."—'*Friend of India,*' 12*th August*, 1847.

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lent system of ventilation adopted through the vessel, and which will tend to keep down the thermometer five or six degrees."

THE '**BENARES.**'—The second steamer, named the *Benares*, was dispatched to India in parts, and put together there in the same manner as the *Patna*, already described.

She left Calcutta on her first voyage on the 4th of March, 1847, *when the river was at the lowest*, and of course took the Soonderbunds route. Fortunately, the Captain was an experienced Ganges navigator. The *Benares*, although a day was lost aground, reached her destination, Mirzapore, on the 16th of March, that is, in 12 days.* The official

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* The first trip of the *Benares* was noticed by the Indian papers in the most candid manner: the following are two extracts, viz.

From the 'Englishman,' 13th March, 1847.

"From a notice in another part of our paper, it will be seen that the Ganges Company's new steamer, the *Benares*, has made the trip to Rajmahal in five days, the shortest time that we believe the distance has ever been accomplished in by the Soonderbunds route. The *Benares* left Calcutta on the 4th instant at 1 P.M., and was at Rajmahal on the 9th, at 2.20 P.M. We extract from the published notices of our river fleet, the time in which this distance has been done on the last upward voyages in January.

Sutledge (Government steamer)	11 days.
Maddock (Inland Company's steamer) . . .	11 ,,
McLeod (ditto) . . .	13 ,,
Benares (Ganges Company's steamer) . . .	5 !!!

From the 'Friend of India,' 18th of March, 1847.

"The voyage of the *Benares* steamer is an event in the annals of river steam navigation in the Gangetic valley which deserves more than a mere passing notice in our brief daily epitome.

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"The *Benares*, the second vessel of that Association, which corstatement before referred to gives 21 days as the average time taken by the Government steamers between Calcutta and Mirzapore in the month of March. This was therefore doing the upward trip in 9 days less time; but the greatest contrast is in the *Soonderbunds* part of this trip, *i. e.* from Calcutta to Rajmahal, and in which the greatest failure was anticipated by many persons,—the *Benares* having done that part in 5 days only, instead of 11 or 12, the time of the steamers upon the tug system.

The down trip of the first voyage of the *Benares* by the Soonderbunds was done in 9 days, or 7 less than the average of the Government steamers in March. The view taken of this performance by the public will be seen by the extracts from one of the leading India journals given below.*

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responds in every respect with the *Patna*, has effected the voyage to Monghir by way of the Soonderbunds *in less than seven days*. It does not convey a full idea of her success to say that no other vessel has ever accomplished the trip in this time; no vessel has ever made any distant approach to such speed. We have not the log-book of the Government vessels before us, but we believe that fourteen days is the average passage by way of the Soonderbunds. The present season of the year, when the river is at the lowest ebb, presents by far the greatest difficulties to river navigation; and the accomplishment of a voyage in so short a time at this period, is therefore the more valuable, as substantiating the fact that steamers constructed on the principle of these vessels are best adapted for the safe and speedy navigation of the river."

* *From the 'Bengal Hurkaru,' 20th July*, 1847.

"The *Benares* steamer performed the passage to Mirzapore in 12½ days: left Mirzapore on the 13th of July, at 1 P. M.; left

During the rest of the dry season, the *Benares'* performances were equally satisfactory, making her voyages to and from Mirzapore within a month each.

Upon the return of the wet season (June, 1847), when the direct route by the Bhaugruttee was taken both ways, her time was, up to Mirzapore, 12½ days; and down, 5¼ days,—absence from Calcutta 20 days, including detentions and stoppages to coal, &c.

The stations on the downward trip of this voyage were reached as follows:

Left	Mirzapore	1 P. M.	on the	13th	July,	1847.
,,	Benares	5¼ P. M.	,,	13th	,,	,,
,,	Ghazepore	8¾ A. M.	,,	14th	,,	,,
,,	Dinapore	6¼ A. M.	,,	15th	,,	,,
,,	Monghyr	6 P. M.	,,	15th	,,	,,
,,	Rajmahal	6 P. M.	,,	16th	,,	,,
Reached	Calcutta	4 P. M.	,,	18th	,,	,,

That is, in five days and three hours.

Both steamers have, since the above period, till

Dinapore the 15th of July, at 6 A.M.; arrived at Calcutta the 18th of July, at 4 P.M.; time occupied in downward trip 5 days and 3 hours; absent from Calcutta on the voyage 19¾ days, including all stoppages."

From the same (at another part).

"The *Benares*, which arrived on Sunday, left Cossipore (four miles above Calcutta) on the morning of the 29th ult., and returned to town on the afternoon of the 18th, having been away somewhat less than 20 days. It must be remembered, however, that she went up the Bhaugruttee, while the *Patna* went through the Soonderbunds. The downward passage of the *Benares* has been rapid beyond example; we believe, being only 5 days 3 hours from Mirzapore to Calcutta."

the date of the latest accounts, been regularly plying on the Ganges, carrying passengers and cargo. They have met no serious accidents,* and their average performances have been such as to justify the conclusion that the success of the principle is complete.

It will be observed that the results in practice more than bear out the theoretical economy of the single vessel system, which was laid down at page 33 at 38 per cent.; and from the proportion of power to resistance adopted in the new steamers, that this economy tells to the benefit of the public by diminishing so materially the time on the passage, and the transport of merchandize. The advantages to owners are not only the economy in time upon the capital invested, but in the time of the personal establishment necessary to work the steamer; so that it would be nearly in the same ratio as the number of voyages in a year, which may be taken at *eleven or twelve* of the new steamers to *six or seven* of those on the tug system.

From the 'Friend of India,' 9th September, 1847.

"The steamer *Benares*, on her last trip, performed the distance between Mirzapore and Chunar, 33 miles, in an hour and thirty minutes, at the astonishing speed (with the current) of 22 miles an hour. During the rains, these splendid vessels generally reach Calcutta before their departure from Mirzapore is announced here."

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* Accidents of a serious nature have frequently happened to the Government steamers and 'flats,' and some have been totally lost. The loss of the *Jellinghee* is a recent instance. The Inland Company's steamer, *General* M^c*Leod*, was lost soon after being placed upon the river.

THE OTHER THREE STEAMERS ON THE NEW SYSTEM.

The 'Chunar'—The 'Mirzapore'—The 'Ghazepore'—Trial Trip and First Voyage of the 'Mirzapore.'

Having, in the preceding pages, given a full general description of the two first of the new steamers, stated the results, and shown the complete success of the new system, it will suffice, since the principle is the same, to notice more briefly the others.

The 'Chunar.'—The third steamer is of precisely similar form and dimensions, and consequently of similar displacement also to the *Patna*, but is designed for cargo only: there are consequently no cabins but those for the captain and officers. She has non-condensing engines of 140 horses' power. Both the vessel and her machinery are lighter than the *Patna*. The weights are as follows:

The vessel, 136 tons—the engines and boilers, 85 tons;—total 221 tons. Draught, without water in boilers, coals, or cargo, 2 feet 1½ inches.

THE 'MIRZAPORE' AND THE 'GHAZEPORE,' the fourth and fifth steamers, being exactly alike in dimensions and power, and nearly alike in other respects, a reference to one will apply with sufficient exactness to both. It will be observed that they are a great deal larger than the *Patna* and the *Benares.*

They are designed for cargo only—cabins for captains and officers, and protection for carriages and horses, and light goods on deck.

The dimensions of the *Mirzapore* are —

Length at load water line, 250 feet.
Breadth of beam, 38 feet.
Ditto over paddles, 66 feet.
Depth amidship, 10 feet.

The displacement is at each 6 inches draught of water as follows:

At 2 ft.	0 in.	330 tons.
2	6	431 „
3	0	533 „
3	6	639 „
4	0	745 „
4	6	863 „
5	0	960 „

The measurement of the hold for cargo is 54,000 cubic feet, clear of every thing, or 1350 tons measurement.

The weight of the vessel alone, including paddle-boxes and deck-houses, without machinery, is 224 tons; the weight of engines, boilers, and paddle-propellers, is 134 tons; consequently the entire steamer complete weighs 358 tons; and the light

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immersion or draught without water in the boilers, or coals, is only 2 feet 2 inches. Thus it will be seen that these steamers possess great carrying power, immense stowage for cargo, are lighter in proportion to the size than the *Patna*, and draw less water.

The chief difference between the design of the iron *vessel* and the *Patna* consists in the deck being convex, or curved upwards transversely, like the back of a violin, and in the *bracing* or *trussing* between the deck and the bottom or 'floor' of the vessel being in the form of a diagonal lattice-work, instead of vertical bars or stanchions, as in the *Patna*. This combination is shown in Plate VIII., and possesses strength and lightness in a high degree. The curvature of the deck was admissible from the absence of passenger accommodation or cabins, and the diagonal framing or 'spine' was admissible from the circumstance of the engines being non-condensing, and entirely above deck.

THE ENGINES, as before stated, are non-condensing high-pressure. They are horizontal, of 8-feet stroke, and the power is nominally 250 horses. The steam-valves are balanced '*double-beat*' valves, operated by '*cambs*' placed upon the '*crank-shaft*,' which cut off the steam at ⅜ths or ⅝ths of the stroke. The boilers are cylindrical, tubular, and eight in number.

These three steamers, after being completely fitted with their machinery in the building yard in London, were sent out to India in parts, in the same manner as the *Patna* and the *Benares*. They are all, except the *Ghazepore*, now (April, 1848) launched on the Ganges.

The *Mirzapore*, at the public trial which took place on the 24th January, 1848, proved perfectly manageable, and steered well, notwithstanding her great size: the speed was fully equal to that of the *Patna*, and close upon 12 miles per hour. This trial trip excited the greatest interest, and is commented upon by the Calcutta press in approving terms, of which the observations at foot are an example.*

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* '*Bengal Hurkaru,*' 25*th January*, 1848.

"THE 'MIRZAPORE.'—The new steamer *Mirzapore*, belonging to the Ganges Company, took another short trial trip yesterday afternoon. After taking on board a large party of gentlemen, and a number of shroffs from the Bazaar, she proceeded down the river at about half-past four P. M., and steamed down as far as the Garden House, against a strong flood-tide. Her head was then put up the river, and she proceeded as far as the Sulkea Salt Golahs, when she again went about and returned to her moorings off Clive Street Ghaut. Her performances gave the greatest satisfaction to every one on board. Notwithstanding her extreme length (257 feet), she turned with readiness on her own centre in little more than two minutes. Indeed, the great ease with which she was managed struck every one. It arises, no doubt, in a great measure from the fact of the engines on each side being entirely disconnected, each paddle-wheel having a separate shaft. This admits of one engine being reversed while the other is moving forward, thereby giving great command over the steamer. The *Mirzapore* is a very fast boat, although we did not ascertain the exact rate of her performances on this occasion. She has high-pressure engines of 250-horse power, which do their

She started upon her first voyage on the 3rd of February, when the river was extremely low and unfavourable to navigation, laden with 230 tons weight of cargo and coals, taking the Soonderbunds route. On the 6th February, she had passed through the Soonderbunds on her upward voyage in the most satisfactory manner, and reached Dinapore or Patna in eleven days from Calcutta.* Thus, under all the disadvantages of a first trip and the bad state of the river, performing this distance in five days less than the average time of the Government Steamers at that season, (see Appendix A.), and giving assurance that when regularly plying she will accomplish the voyage in the same or less time than the *Patna* and *Benares*, as shown in the preceding pages.

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work with far less noise and vibration than might be expected. She will carry 350 tons of cargo with a very small draught of water."

* '*Friend of India,*' 17*th February*, 1848.

"The Ganges Company's new boat the '*Mirzapore,*' known as the 'Big Boat,' the 'Great Eastern,' which we noticed as having started on her first voyage, reached Dinapore in eleven days from Calcutta, which, taking the season of the year into consideration, the lowness of the water, the frequency of sand-banks, and the want of any regular channel, she has done exceedingly well. She passed through the intricate channels of the Soonderbunds beautifully, removing all doubts and fears that were entertained by many on this head before her starting. The river is worse in many parts this year than has been known for many years."

FINANCIAL BEARINGS.

Cost of the new Steamers—Charges of running them—Competition.

The new steamers put upon the Ganges up to the present time consist, as has been stated, of

Two of 120	horses' power	each	for passengers and cargo,
One of 140	do.		for cargo only,
Two of 150	do.	each	for cargo only,

In all, five steamers, aggregating 880 horses' power. Their cost is made up of,—1st, the price of the vessels and engines in London;—2ndly, the expense of transporting them in parts and pieces to Calcutta;—and 3rdly, the charges of re-constructing in India.

Owing to the constructors in London having kept in view in their design of the engines and boilers, that the parts were required to be adapted for *shipment,*—to the preparations made by them for facilitating the business of putting together the parts abroad,—and to economical and active measures in executing the work in India,—the total cost of the whole five steamers completed and started on the Ganges, exclusive of *spare* boilers, &c., and of interest upon the capital employed prior to the steamers coming into activity, does not exceed the sum of £96,000, which is made up thus:

Steam engines (880-horse power)	£41,800
Vessels, cabins, &c.	39,686
Cost in London	81,486
Transportation to India	5,875
Re-construction and equipment	9,199
Cost on the Ganges	£96,560

To which perhaps should be added interest for an average period of eighteen months upon a part of the sum, say upon £55,000, at 7½ per cent. per annum, £6187. This would make up a sum of £102,747. No preliminary expenses or charges for the 'Direction' were incurred. Be it observed this is no mere 'estimate,' but the actual cost of the thing done. They only who have *carried out* a similar operation connected with a foreign country at a great distance, can correctly understand the difference. To accomplish it required the reposal of confidence the most implicit and full on the part of the employers, joined to an execution the most careful and conscientious on the part of the employed.

The charges of 'running' these steamers are made up of items as nearly as possible like those incurred by steamers in this country; they may be classed under the heads of—1st, Fuel. 2nd, The Personal Establishment, (or the salaries and wages of the commander, engineers, officers, and people on board.) 3rd, Stores and provisions. 4th, Repairs. 5th, Annual depreciation. 6th, Insurance against loss and fire. 7th, Management. The experience had upon this subject, not being as yet sufficiently extended, nor the time sufficient to bring the arrangements into that order which results in economy with efficiency, an attempt to exhibit the total charges would only be likely to mislead.

The item of fuel is at present a heavy one (about £350 each voyage of the *Patna*); there is, however, little doubt that in another year or two coals will be delivered on board at a lower price. The cost of the personal establishment of each steamer is, even at its present high amount (about £148 each voyage of the *Patna*), much less than the steamers on the tug system.*

For the same reasons of insufficient experience, no statement of the income of the new steamers can yet be given that would be of any value. That it is satisfactory will hardly be doubted. When the whole of the steamers composing the line shall have been in activity for a year, a correct statement of this nature will be of much public interest.

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* The personal establishment of a Government steam tug and 'cargo flat' is as follows: 2 captains, 2 mates, 1st and 2nd engineers, 1 clerk, 2 seraings, 2 tindals, 8 secunnies, 24 lascars, 1 tindal of stokers, 8 stokers, 4 cooks, 2 topazs; and costs, including provisions, about £200 per month, or £2400 per annum, which, divided by even *seven* voyages per annum, gives £345 per voyage.

That competition will reduce the present rate for freight and passengers is not to be doubted; they can bear some reduction, and so long as the competition is fairly carried on, it were absurd to object to it. The steamers of the Indian Government, however, it must be remembered, are, although carriers of public freight and passengers, not dependent for their existence or success upon that source alone, and there is not the regulating check upon their proceedings of watchful shareholders looking for dividends. The subordinate officers and Government servants, who hold their places in connection with the steamers, have of course an interest in keeping them in activity, that being the only condition of their continuance in office. In such a case it is easy to see that a competition, however desirable and however fair it may be at first, is liable to become unfair to the public companies, unless minimum rates are fixed upon and strictly adhered to by the Indian Government for the conveyance of *public* freight by the Government steamers, that will leave a fair return for the capital embarked by shareholders in the steam navigation companies. To reap the profits of trade was not the object for which the Government of India introduced Steam on the Ganges; and it would be derogatory to its character as a paternal Government, were it to permit its servants, in a spirit of rivalry, to employ its steamers in an unequal competition with those of private individuals. The true interests indeed of the Government are so obviously the reverse of this course, and so decidedly in harmony with the extension of steam navigation by the public, that it would seem hardly necessary to refer to the subject.

CONCLUDING REMARKS.

The Pilot Service on the Ganges—Improvement of the Navigation.

THE unstable nature of the bed of the Ganges, noticed in a preceding page, is a great impediment in the way of obtaining an effective pilot service; but in the Lower Mississippi, although there is a greater depth of water, it is nearly as changeable, and yet we find a river-pilot service of the most efficient kind. Three things combine to produce the difference:—on the Mississippi, hundreds of steamers have for many years been plying; the pilots are men of high intelligence, and generally of education, and they are regularly trained to their vocation, and do nothing else; whereas on the Ganges, until recently, only five or six steamers have been on the river;—the men who act as pilots to them are not even of the most intelligent class of Natives, and they have neither been trained to the business, nor do they follow it regularly. The consequence is, they are merely pilots in name, and the captain of the steamer is virtually, in most cases, obliged to act as pilot himself. From an attentive observance of the river and of the present system, or rather *no*-system of pilotage, the writer is led to conclude that, notwithstanding the rapidity of the changes that take place at particular seasons in its bed, good pilotage would be almost invaluable. One of the main obstacles to obtaining this is now in the course of removal in the increase of the steam fleet; indeed a school sufficiently large to make a beginning even now exists; it only remains to organize in a proper and permanent manner a public pilot service on a large and liberal plan. Mere local knowledge must be disregarded; a higher class of men must be attracted to the service by better pay, and the stimulus, applied *to keep up* attention, of *prizes* for the greatest amount of good service in each division of the river.

IMPROVEMENT OF THE NAVIGATION.—When the size of the Ganges' river and the large volume of water poured down by it, even in the dry season, are mentioned, persons unacquainted with the rivers of India are apt to smile incredulously on its being added that the *depth* in the channel in many places does not exceed 3 feet 6 inches or 4 feet in the dry season. The fact, however, cannot be doubted for a moment.

Again, when it is considered that a steamer that can carry only itself at 2 feet 6 inches draught, shall carry 200 tons at 3 feet 6 inches, 400 tons at 4 feet 6 inches, it will be perceived that the last foot is worth the other three and a half. A consequence flowing from this is, that with the first-named draught of water, the steamer, if dependent upon freight, could only be run at a loss; with the second, would probably pay a profit; and with the third, would return a large profit.

But the advantages which would result to steam navigation from a greater depth of water, of one and a half or two feet, in the present shallow parts of the river, do not stop here:—a better *form* might be given to the freight steamers, so that less power would propel them at the same speed; and less power of course implies a lesser weight of machinery and fuel, with a smaller expense of running. The rates of steam freights might be reduced and the sphere of utility enlarged. Passenger steamers of a speed of 16 or 18 miles an hour, with spacious and elegant accommodation for a hundred passengers, and which would, with a good pilot service, perform the distance *up* to Allahabad in from 5 to 7 days, and *down* in 2½ to 4 days, according to the season, might be introduced on the Ganges. The traffic by the Native boats, too, would be greatly facilitated.

The importance of increased depth, thus shown to be so great, naturally leads to the enquiry whether it is practicable to obtain it, and if it be practicable, whether at an expense that could be met. To enter at any length into this question would be inconsistent with the subject of this little work, and would expand it beyond due limits. The author cannot, however, allow it to leave his hands without recording his convictions and indicating his views in reference to it.

It has been already stated that the bed of the river is composed of sand; the exceptions (of which there are a few) do not affect the question, because there is abundance of depth over the hard parts of its bed. This sandy formation, which is the cause of the evil of the extreme shallowness, affords facilities for remedying it; and the deepening of the channel where necessary, *without* permanent or costly engineering works, is a task which the author believes to be perfectly practicable. All that is wanted, is, to aid the slow but certain powers of Nature by the application of scientific skill and practical experience, combined with the cheap labour and the simple "means and appliances" already in existence in India, and with, in some places, the steam engine applied to machinery afloat. In some places the improvements might be effected in a single season, whilst in other cases years of steady perseverance in the necessary measures would be required; and even when the deepening is accomplished, the same measures must be continued in a lesser degree, in order to secure what may have been gained.

The principles upon which these views are based, are,—1st, That the water of the Ganges holds in suspension the fine sand with which it forms the shallows, the bars, and the banks. 2nd, That just in the measure that the water is kept in agitation, (whether by the natural action of the current or other means,) will it hold more or less of this fine sand in suspension. 3rd, That wherever the agitation exceeds a certain degree at any spot, there the water is deepening; and wherever at any spot it is minus this degree of agitation, there the water is shoaling. This is aptly illustrated by a circumstance of common occurrence to the new steamers. From the great length of one of these vessels, when it gets aground upon a shallow in an oblique position with respect to the direction of the current, the water on the side where the velocity is encreased by the obstruction of the vessel becomes in a little time deeper, and a channel is formed which generally enables her to be got off; and on the other, or lee side, where the velocity of the current is diminished, it shoals up so that in a few hours (should the vessel remain fast so long) a sandbank makes its appearance above the surface of the water, upon which one may jump out.

But an example of what was done by very small means, in an instance that came within the author's knowledge, will serve to show more definitely what might be done to improve the navigation by adequate measures. In the month of April (the worst part of the dry season) in 1847, at a place a few miles above Benares, the water had gradually shallowed to 2 feet 6 inches. Upon this shoal several of the Government steamers, as well as the new steamer *Benares*, stuck fast, and met with much detention before getting over. Being near a military station, the officer in command of it took great interest in the proceedings of getting off the *Benares;* and after she had passed down, he in the most spirited manner (acting upon the writer's suggestion, that some good result might be produced by manual interposition) collected a number of natives, whom he directed so skilfully to disturb the sand at the bottom of the water with pointed poles or bamboos, that, in a few days, so much of the sand had been carried away by the current, that a channel through the *shoal* of 4½ feet deep, and amply wide enough for a steamer, was thus formed. This channel then remained open during the rest of the dry season, and the steamers passed through it without once grounding.

It is perfectly curious to observe, as the writer has often done, the way in which any slight artificial obstruction, such as even a pole stuck into the bottom, or parts of wrecks of native boats, collects sand about it, and produces a miniature bank or shoal; the effect of which is, of course, to obstruct the passage of the water at the spot, and to force it to run at a greater velocity on one side, and consequently to deepen the channel there.

Should the Indian Government seriously turn its attention to the truly important matter of improving the Navigation of the Ganges, it would be highly desirable, in order to obtain something like a guarantee for the carrying out of the great work,—and when carried out, for its being preserved in at least an equally available state,—that the principle of making the remuneration of the Engineer-in-chief commensurate with the amount of good effected, rather than with the duration of service, were adopted from the first, and continued ever afterwards. The field is grand and vast; let a fit labourer be selected to operate in it, and let him be paid for his work, and that liberally. The means of effecting the contemplated improvements would not be wanting: they may indeed be said to exist already in the tolls collected on the boats passing through the Bhaugruttee to the amount of £16,000, and through the Soonderbunds to the amount of £17,000 per annum, and even additional tolls would be readily and freely paid both by the Native boat and the Steam traffick for real improvements in the navigation; but, as already observed, permanent and costly engineering works are not necessary, and it is believed the outlay required would be very moderate, whilst enormous good to the country would be the result.

THE END.

APPENDIX A.

Average Time allowed for Government Steamers, between CALCUTTA *and* ALLAHABAD, *and intermediate Stations.**

This Statement exhibits the estimated time or average number of days occupied by a Steamer in passing from Station to Station between Allahabad and Calcutta.

From Allahabad.	To Mirzapore.	Benares.	Ghazepore.	Patna or Dinapore.	Mongheer.	Bhaugulpore.	Rajmahal.	Berhampore.	Bogwangolah.	Rampore Baulea.	Comercallee.	Koolna in the Soonderbunds.	Calcutta.	Total.
Month.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.
January . .	1	1	1	2	2	½	½	..	½	½	1	2½	3½	16
February .	1	1	1	2	2	½	½	..	½	½	1	2½	3½	16
March . .	1	1	1	2	2	1	1	..	½	½	1	2½	3½	17
April . .	1	1	1	2	2	½	½	..	½	½	1	2½	3½	16
May . . .	1	1	1	1	2	½	½	..	½	½	1	2½	3½	15
June. . .	1	1	1	1½	1	½	½	1	..	..	..	..	1	8
July . . .	½	½	1	1	1	½	½	1	..	..	..	..	1	7
August . .	½	½	1	1	1	½	½	1	..	..	..	..	1	7
September .	½	½	1	1	1	½	½	1	..	..	..	..	1	7½
October. .	1	1	1	1½	1½	½	½	..	½	½	1	2½	3½	15
November .	1	1	1	1½	1½	½	½	..	½	½	1	2½	3½	15
December .	1	1	1		2	½	½	..	½	½	1	2½	3½	16

This Statement exhibits the estimated time or average number of days employed by a Steamer in passing from Station to Station between Calcutta and Allahabad.*

From Calcutta.	To Comercallee.	Baulea.	Berhampore.	Rajmahal.	Bhaugulpore.	Mongheer.	Patna or Dinapore.	Ghazepore.	Benares.	Mirzapore.	Allahabad.	Total.
Month.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.
January	6	6	..	10	11	13	16	19	20	22	24	24
February	6	6	..	10	11	13	16	19	20	21	23½	23½
March	6	6	..	10	11	13	16	19	20	21	23½	23½
April	6	6	..	10	11	13	15	18	20	22	24	24
May	5	6	..	9	10	11	14	17	18	19	21	21
June	..	..	4	6	6	9	11	14	15	16	18	18
July	..	..	4	7	8	9	11	15	17	18	21	21
August	..	..	4	8	9	10	13	16	17	19	21	21
September	..	..	5	8	9	11	14	18	20	21	23	23
October	6	7	..	9	10	12	15	18	20	22	24	24
November	7	9	..	11	12	14	17	20	21	23	25	22
December	6	8	..	10	12	13	16	19	21	23	25	25

Fort William, Marine Board Office,
4th Feb. 1841.

(Signed) J. H. JOHNSTON,
Cont^{r}. of Gov^{t}. Steam Vessels.

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* The times are of course frequently greatly exceeded by casualties, &c.

APPENDIX B.

COMPILED FROM OFFICIAL RETURNS.

***Statement showing the Number and Tonnage of Vessels resorting to* CALCUTTA, *and also Value of the Imports into and Exports from* BENGAL, *for the Years* 1833–4, and 1843–4.**

ARRIVALS.	CALCUTTA. 1833–34.		1843–44.	
	Ships.	Tons.	Ships.	Tons.
Under British Colours . . .	330	122,952	494	208,055
„ French	31	10,771	47	13,673
„ Dutch	2	352	5	1,868
„ Portuguese	1	350	5	1,101
„ American	22	7,342	15	6,893
„ Arab	10	4,386	10	4,845
„ Native	432	36,616	196	17,584
„ Burmese	1	400	2	500
„ Austrian	„	„	„	„
„ Swedish	1	302	„	„
Total of Arrivals .	830	183,471	772	254,519
TOTAL VALUE OF IMPORTS of the same Periods, . . at 2*s*. ℘ Company's Rupee.	Sicca Rupees. 195, 81, 986 £2,068,745		Company's Rupees. 493, 25, 807 £4,932,580	
DEPARTURES.	Ships.	Tons.	Ships.	Tons.
Under British Colours . . .	333	122,845	532	224,318
„ French	29	10,416	45	13,085
„ Dutch	2	352	4	1,580
„ Portuguese	1	350	3	1,207
„ American	19	6,765	18	8,372
„ Arab	12	5,221	9	4,223
„ Native	432	36,616	197	18,045
„ Austrian	„	„	„	„
„ Swedish	1	315	„	„
„ Spanish	„	„	3	580
„ Burmese	„	„	2	344
Total of Departures	829	182,880	813	271,754
VALUE OF EXPORTS of the same Periods, . . at 2*s*. ℘ Company's Rupee.	Sicca Rupees. 3, 79, 12, 649 £4,044,015		Company's Rupees. 9, 78, 66, 356 £9,786,635	

In estimating the gross trade of Calcutta—the amount of its imports and exports together—an allowance of about 7 per cent. in 1833–4, and above 3 per cent. in 1843–4, should be made for imports re-exported.

APPENDIX C.

Statement of Traffic on the Rivers Ganges *and* Hooghly, *from officially authenticated Government Returns.*[*]

Goods Traffic to Calcutta.	Tons.
In the year 1844–5, it appears, from the official statement of the collector of tolls at Jungeepore, on the Bhaugruttee River, that boats passed through that branch of the river, containing 21,497,750 maunds; or, taking 27 maunds to the ton, the tonnage of the laden cargo boats was . . .	796,213
To catch the vessels coming through the rivers of the Soonderbunds, a toll is imposed on the vessels navigating Tolly's Nullah, and the circular Canal at Calcutta. The toll is half a rupee for every hundred maunds of tonnage (boats of less than a hundred maunds not being counted), and in 1844–5 it yielded 177,791 rupees; showing that 35,558,200 maunds of tonnage had passed through it, which, at the rate of 27 maunds to the ton, gives per annum	1,316,970
Traffic in native boats is therefore	2,113,183
In 1844–5, seven steamers made 39 trips upwards, and carried 112,765 measurement feet, and 1,156,909 lbs. weight of cargo. Reckoning a cubit foot to weigh 30 lbs., we have, carried upwards by steamers	2,027
The goods carried downwards is about	675
Total of Goods carried on the Ganges and Hooghly . . .	2,115,885

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[*] *Vide* First Report of Directors of East Indian Railway Company.

APPENDIX D.

Showing the Traffic in one month from the Upper Ganges and the Jumna Rivers into the Main Ganges, and vice versâ.*

				Tons.	Tons.
Traffic on Jumna, taken at Allahabad Bridge of boats during 25 days of April, 1841.					
	DOWNWARDS.				
36,024	Bags of salt	at 12 bags per ton	3,002		
52,080	Bales of cotton	„ 8 „ „	6,510		
828	Bags of saltpetre	„ 12 „ „	69		
2,000	Hides	„ 50 „ „	40		
	Add for 5 days		1,924	11,545	
	UPWARDS.				
13,119	Bags of rice	at 12 bags per ton	1,193		
2,240	Do. cocoa nuts	„ 12 „ „	170		
2,347	Spices	„ 12 „ „	195		
2,815	Miscellaneous	„ 12 „ „	234		
	Add for 5 days		358	2,150	13,695
Traffic on Upper Ganges, as taken at Allahabad Bridge of boats in April, 1841.					
	DOWNWARDS.				
54,700	Pieces of Kurwah cloth	at 500 pieces per ton	109		
1,004	Bags of mustard	„ 12 „ „	84		
6,305	Do. saltpetre	„ 12 „ „	525		
7,162	Bales of cotton	„ 8 „ „	895		
12,250	Hides	„ 120 „ „	102		
4,450	Miscellaneous	„ 12 „ „	371		
13,700	Horns	„ 120 „ „	114	2,200	
	UPWARDS.				
1,348	Wine chests	at 12 per ton	112		
1,013	Bags of cocoa nuts	„ 12 „	84		
7,394	Do. rice	„ 12 „	616		
4,189	Do. spice	„ 12 „	349		
4,940	Iron and tin	„ 10 „	494	1,655	3,855
In addition to this, 94 boats containing passengers and goods, not counted, and may be estimated at 40 tons each					3,760
Total amount of Traffic on Ganges and Jumna in April, 1841					21,310

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* From which some estimate may be formed of the traffic in a year at this the point of junction between the Main Ganges and its two great tributaries.

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